

## Exploring variation in dimensions of obstetric forceps

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## **Title page**

### **Full title:**

Exploring variation in dimensions of Obstetric forceps

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Despite increasing rates of caesarean section and introduction of vacuum extraction devices obstetric forceps still account for 6.6% of deliveries in England (1), with Neville Barnes' (NBF) and Wrigley's (WF) the most commonly used types in the UK. Neonatal complications of forceps assisted delivery include soft tissue trauma to the face and scalp (cuts and bruises), facial nerve injury, and less commonly depressed skull fractures and intracranial haemorrhage. Maternal complications include damage to nerves and soft tissue (vagina, perineum, and pelvic floor), which can cause genital prolapse and affect sphincter function leading to urinary and faecal incontinence (2). We believe dimensions of forceps play an important role in determining these outcomes, therefore we investigated the degree of consistency in dimensions between: a) different pairs of forceps of the same type, b) NBF and WF, and c) product specification between different manufacturers.

We measured the dimensions of 100 pairs of forceps (50 NB and 50 Wrigley's) at two UK hospitals [table 1]. Measurements included: [A] - length of handle and shank; [B] - blade length; [C] - greatest distance between the blades; [D] - distance between blade tips; and [E] - width of the blades [figure 1]. Five European manufacturers provided us with their specifications [table 1].

Our results showed variation in all recorded measurements in line with previous studies (3, 4). As in most obstetric units the instruments were accumulated over time from different manufacturers, and are seldom replaced due to their metal construction. Obstetric forceps are covered by the European Union Medical Device Directive 93/42/EEC (5), and while this requires surgical devices to comply with 'essential requirements', few of these apply to forceps (e.g. grade of surgical steel). There are no prescriptive or 'harmonized' standards for their dimensions and so each manufacturer uses individual specifications. It is not clear why dimensions have undergone changes over time but this probably happened secondary to

historical requests by obstetricians. This, combined with a 2-5mm acceptable margin of error during production (personal communication) are the most likely explanations for our findings.

Obstetric forceps were initially designed for use following protracted labour, with the fetal head still high within the birth canal, having undergone severe moulding (becoming flattened and elongated). This explains their design, with extended shanks and long blades with a shallow curve (inter-blade distance corresponding to the average BPD at 29-30 weeks gestation) (6), allowing further compression of the head to ease extraction (3, 4). Current obstetric practice prevents prolonged labour, head moulding is not as severe, and for deliveries where the fetal head is high, caesarean section is performed. During delivery every effort is made to avoid excessive compression of the fetal head. Nevertheless, it is not possible to guarantee this with the current forceps' dimensions and variability therein.

Therefore it is concerning that our measurements are similar to the original dimensions of NBF and WF [table 1]. While manufacturing specifications show a degree of evolution [table 1], paradoxically this will only increase variation due to the different specifications used by different companies, and as new forceps are incorporated into current stock. Moreover, while differences in dimensions of handle and shank length between NBF and WF is understandable, blade dimensions should not differ since they are both designed for term deliveries.

We believe it is time to redesign obstetric forceps based on biometrics of the fetal and neonatal head. The recent advent of 3D printing and modern properties of plastics should make it possible to mass-produce single-use forceps. This would ensure consistency of measurements more suited for the neonatal head, so reducing risk of complications for mother and baby.

### **Declaration of Interest statement**

KI conceived the idea of Safeceps® (a regulated obstetric forceps that measures, displays and archives traction and compression forces). KI is a board director for Promedical Innovations, a university Spin-off that was set up to see the development and marketing of Safeceps®.

AQI reports no declarations of interest.

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**Table 1** Measurements of Neville Barnes' and Wrigley's forceps compared to original specifications and measurements of master instruments [2, 3], and current manufacturing specifications from a sample of European companies (anonymised) [personal communication].

	Neville Barnes' forceps			Wrigley's forceps		
	Original specification (mm)	Mean measurement (n=50) (mm)	Current manufacturing specifications (n=4) (mm)	Measurements of master instruments (mm)	Mean measurement (n=50) (mm)	Current manufacturing specifications (n=5) (mm)
A		220 (SD=12, range 200 - 245)	230		127 (SD=5, range 110 - 136)	125-145
B	171.0	163 (SD=7, range 153 - 177)	160-170	131 - 134	146 (SD=5, range 138 - 166)	130-160
C	76.0	83 (SD=4, range 73 - 93)	85-90	77 - 79	77 (SD=3, range 68 - 84)	80-95
D	25.4	24 (SD=3, range 17 - 31)	20-30	23 - 24	23 (SD=3, range 13 - 28)	20-30
E		53 (SD=3, range 46 - 57)	50-60		49 (SD=2, range 45 - 52)	50-60



**Fig. 1** Graphical representation of obstetric forceps (created using Google SketchUp)

